

AFFECTED ENVIRONMENT

The topics covered in this chapter and the “Environmental Consequences” chapter are those resources of Big Thicket National Preserve that would potentially be affected by the implementation of any alternative being considered in this environmental assessment. The topics are

- water quality
- air quality
- soundscapes
- wildlife and wildlife habitat
- threatened or endangered species or species of special concern
- shorelines and shoreline vegetation
- visitor experience, and visitor safety and conflicts
- cultural resources
- socioeconomic environment
- preserve management and operations

Impact topics that were deleted from further consideration are discussed beginning on page **Error! Bookmark not defined.**

GENERAL PROJECT SETTING

The Big Thicket area of east Texas originally covered an area of approximately 3.5 million acres. It is still characterized by diverse and beautiful vegetation and extensive water-based resources. Variations in geology, climate, soils, elevation, and drainage have resulted in the biological diversity of the area. Land uses in the region, though benefiting the area economy, have reduced the Big Thicket to mere remnants of its former extent. The national preserve was established to ensure the preservation, conservation, and protection of a portion of this once great forest complex.

The Big Thicket, often referred to as a “biological crossroads,” is a transition zone where southeastern swamps, eastern deciduous forest, central plains, pine savannas, and dry sandhills meet and intermingle. The area provides habitat for rare species and favors unusual combinations of plants and animals. The Neches River is the primary drainage of the national preserve, capturing the majority of water from precipitation and overland flow.

In recognition of its diversity, the national preserve was designated a biosphere reserve in 1978 by UNESCO. It shares this distinction among 337 biosphere reserves in 85 countries worldwide. A biosphere reserve is a place for long-term study of changes in the physical, biological, and human environment. It conserves the natural resources and special natural qualities of its region (U.S. Department of State 1996).

The national preserve contains 15 separate units, comprising 96,804 acres (see the Location map on page **Error! Bookmark not defined.**). The 15 units of the national preserve lie in east Texas, north of Beaumont and northeast of Houston, and occupy portions of Hardin, Liberty, Orange, Jasper, Polk,

Tyler and Jefferson Counties. PWC use is restricted to a relatively small portion of the entire national preserve: the Neches River south of its confluence with Village Creek, and Pine Island Bayou up to the mouth of Cook's Lake. This area falls within the Beaumont Unit and the southern tip of the Lower Neches River Corridor Unit and includes parts of Orange, Hardin, and Jefferson Counties.

WATER QUALITY

Water is one of the primary resources in the national preserve. Most of the national preserve units either contain or are adjacent to large, perennial streams. In addition to these major river/stream reaches, the national preserve contains a wide variety of minor hydrologic features: floodplains, sloughs, oxbows, baygalls, acid bogs, and low-order tributary streams. All units of the national preserve are within the watershed or basin of the Neches River, except for the Menard Creek Corridor Unit, which is in the Trinity River basin. Both of these drainage basins trend to the southeast and have gentle slopes with channels that meander from their headwaters to the Gulf of Mexico.

NECHES RIVER WATER QUALITY

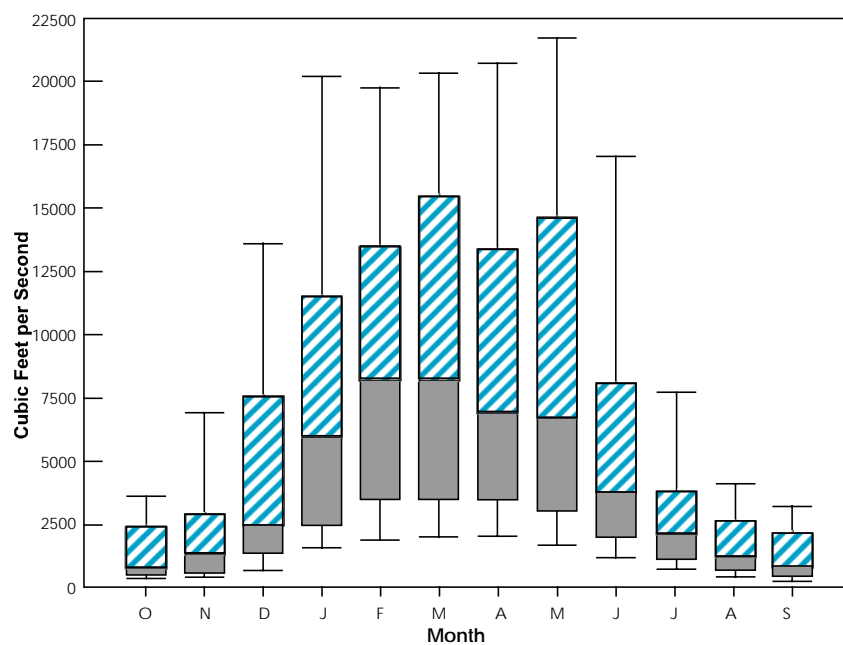
The primary focus of this section is the water quality of the Neches River, especially in the area where personal watercraft are permitted (see the PWC use area shown on the Alternative A map). The entire Neches River basin is roughly 200 miles long by 50 miles wide, draining an area of approximately 10,000 square miles. The Angelina River drains the northern third of the basin, while the Neches drains the remaining two-thirds before entering the Gulf of Mexico through Sabine Lake, southwest of Beaumont. Major tributaries to the Neches within the national preserve are Big Sandy Creek/Village Creek, Turkey Creek, Pine Island and Little Pine Island Bayous, Hickory Creek, and Beech Creek (see the Location map).

The Neches is a large, meandering river with regulated flow. It also shares certain similarities with blackwater rivers, a subset of coastal plain rivers of the southeastern United States, since it connects to many unnamed creeks and sloughs that affect both the hydrology and hydrochemistry of the surface water environment. Sloughs channel and capture water. They are located within the active floodplain and therefore are subject to a great degree of hydrologic exchange with mainstem drainages. In addition to the periodic input of floodwaters, sloughs may receive sediments during floods. Water quality in sloughs can vary from that observed in the mainstem watercourse to that more typical of acid bogs, depending on the elapsed time between flood events (NPS 2001c).

The tidal portion of the Neches River watershed extends from the confluence with Sabine Lake upstream into the southeast portion of the Beaumont Unit. Flows in the river downstream of this area are influenced by tides, water quality of the ocean, and discharges from the upper watershed. The tidal segment is highly developed and industrialized; it is dredged to maintain a navigation channel.

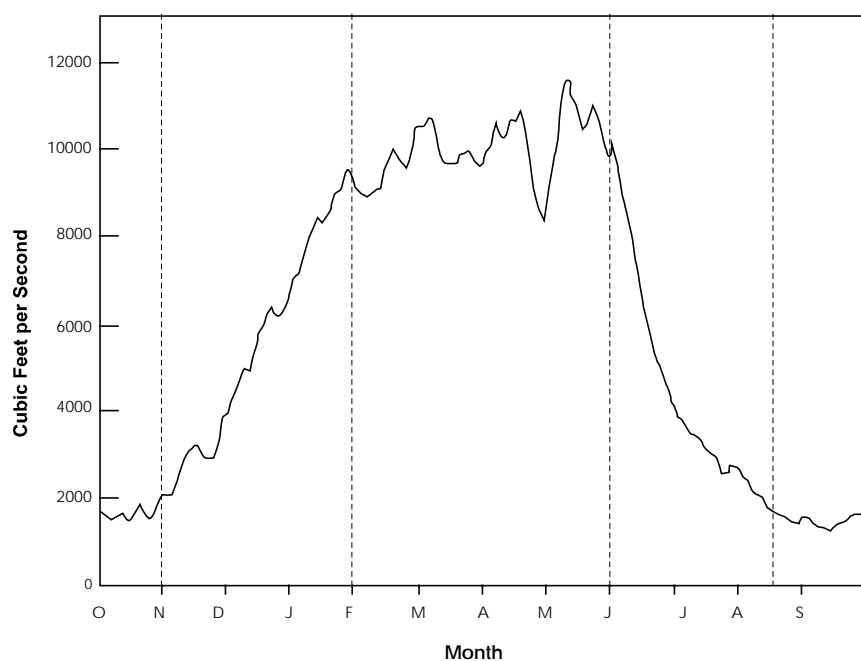
Flow Characteristics Affecting Water Quality. Flow characteristics strongly affect the water quality in the Neches River, since flow influences dilution, transports contaminants from upstream sources, and determines the extent of saltwater intrusion. Both the U. S. Geological Survey and the National Weather Service operate a number of stream gages within the Neches River basin. Analysis of the 71-year flow record from the USGS gage at Evadale on the Neches River indicates that peak flows generally occur between February and June, and that 90% of these peaks are below 22,500 cubic feet per second (NPS 1995a; see Neches River Representative Mean Annual Hydrograph and Distribution of Daily Flows).

REPRESENTATIVE MEAN ANNUAL HYDROGRAPH



Note: Horizontal lines show 10th to 90th percentile; boxes show 25th to 75th percentile; internal line is the median.
Source: 71 Year Record at Evadale, TX

DISTRIBUTION OF DAILY FLOWS



Source: 71 Year Record at Evadale, TX.

Within the Neches River basin are two major impoundments within 30 river miles upstream of the national preserve. The timing of and releases from these reservoirs affect downstream water quality. B. A. Steinhagen Lake is upstream of the Upper Neches River Corridor Unit and normally occupies 16,800 surface acres. Sam Rayburn Reservoir, the larger of the two, is on the Angelina River about 25 miles above the confluence of the Neches and Angelina Rivers. It includes parts of five counties and occupies 114,500 surface acres (at normal level). At Steinhagen, Town Bluff Dam (known as Dam B) serves to control the release of water from Rayburn. When operated in conjunction with the dam at Rayburn, Steinhagen's surface acreage normally ranges between 11,000 and 14,000 acres. Both dams are operated by the Fort Worth District of the Army Corps of Engineers (NPS 2001c).

The construction and subsequent operation of these reservoirs have altered the flow characteristics of the Neches River by reducing the frequency and duration of both high and low flows (Gooch 1996; Hall 1996). Changes in the duration and frequency of floods have also resulted in changes in species composition and distribution of floodplain forest communities (Hall 1996).

In addition to the control of these reservoirs, water diversion may also alter the natural flow and behavior of a river or stream. A number of water diversions exist within the Neches River basin, including the LNVA canal and the city of Beaumont drinking water intake. However, an analysis of basin diversions concluded that the amount of water annually diverted is relatively small compared to annual fluctuations (NPS 2001c).

Finally, flow in the Neches can be influenced by saltwater barriers used to protect the LNVA freshwater diversion points when the Sam Rayburn Reservoir water levels are low. Temporary barriers have been installed over the years, and there is a breached barrier in the Neches River south of the Lakeview sandbar area. A new permanent barrier is being constructed about 0.5 mile south of the national preserve boundary (south of the Confluence boat launch).

State-Designated Stream Segments and Uses. In accordance with EPA guidelines, the Texas Natural Resource Conservation Committee (TNRCC) has classified major stream segments within the state according to designated uses. In order to support or achieve the designated uses of these stream segments, the committee has promulgated specific numerical criteria for each use and each segment.

The area of PWC use includes portions of stream segments 601 and 602, as defined by the Texas Surface Water Quality Standards. Segment 602 consists of the Neches River below Steinhagen Lake and includes most of the area where personal watercraft are used. Village Creek and Pine Island Bayou are major tributaries to this segment. Segment 601 is the tidal portion of the Neches River, which extends from the confluence with Sabine Lake in Orange County upstream to a point 7 miles upstream from I-10 in Orange County (TNRCC 2002).

Designated uses for segment 602 are contact recreation, high quality aquatic habitat, and public water supply. Designated uses for segment 601 are contact recreation and intermediate aquatic habitat. The city of Beaumont operates three drinking water intakes on the Neches: one just south of Collier's Ferry (south of the national preserve), one at Bunn's Bluff about 0.5 mile north of the confluence with Pine Island Bayou, and one far north in Jasper County (Miller, pers. comm.). The Bunn's Bluff intake (Photo 1) is within the portion of the Neches used by personal watercraft. The Lower Neches Valley Authority also withdraws drinking water from the Neches River in this area. It operates several intakes on the LNVA canal, which connects the Neches River near the Lakeview sandbar to Pine Island Bayou west of Cook's Lake.

PHOTO 1: CITY OF BEAUMONT DRINKING WATER INTAKE (BUNN'S BLUFF)

Three permitted discharges exist along segment 602: two domestic outfalls and one industrial outfall (paper mill at Evadale). Along segment 601, accidental spills of oil and other contaminants from riverside industries or ships have occurred and continue to threaten water quality on an acute as well as a chronic basis (TNRCC 1996). Both segments 601 and 602 had been designated for many years as “water quality limited” or “impaired,” due to fecal coliform and cadmium levels. However, as of 1998, both were delisted due to changes in the listing criteria, and now both segments officially support their designated uses (TNRCC 2002).

Antidegradation Policy. The state-established antidegradation policy is designed to protect water quality at existing levels and to prevent a deterioration of water quality below achievable uses for a given stream segment. The policy has three levels of protection: (1) existing uses will be maintained and protected; (2) for instream segments whose quality exceeds designated uses, degradation may only be allowed for important social and economic development; and (3) no degradation will be allowed for outstanding natural resource waters. No waters in the state are currently designated as an outstanding natural resource. For the Neches River, antidegradation means that existing uses should be maintained and protected.

Water Quality Data. A relatively large amount of water quality data have been gathered for standard pollutants in the preserve’s major drainages. These data are essentially of two types: studies that were either very limited in space and/or time, or more comprehensive monitoring programs where the period of data collection spanned months or years and included numerous stations. Separate monitoring programs have been undertaken by both the U.S. Geological Survey and the National Park Service, and a detailed “Baseline Water Quality Data Inventory and Analysis” was published in 1995 that summarizes data available from five EPA national databases (NPS 1995a).

The National Park Service has established 15 water quality monitoring stations within six national preserve watersheds or subwatersheds: Beech Creek, Mill Creek, Big Sandy Creek/Village Creek,

Black Creek, Menard Creek, and Pine Island Bayou. Additionally, there are five water quality stations on the main stem of the Neches River. Between 1984 and 1994 nearly monthly measurements were made at 14 of the 20 stations, resulting in 1,781 records of field parameters and 678 records of lab parameters (Hall and Bruce 1996).

Very few monitoring programs have examined the primary pollutants of concern related to PWC use. However, past evaluations of baseline chemistry for the Neches River in the area where PWC use occurs indicate that some EPA water quality criteria (zinc, cadmium, copper, and lead) have been exceeded, and farther downstream the criteria for turbidity, pH, dissolved oxygen, chlorides, sulfates, and fecal coliform have been exceeded.

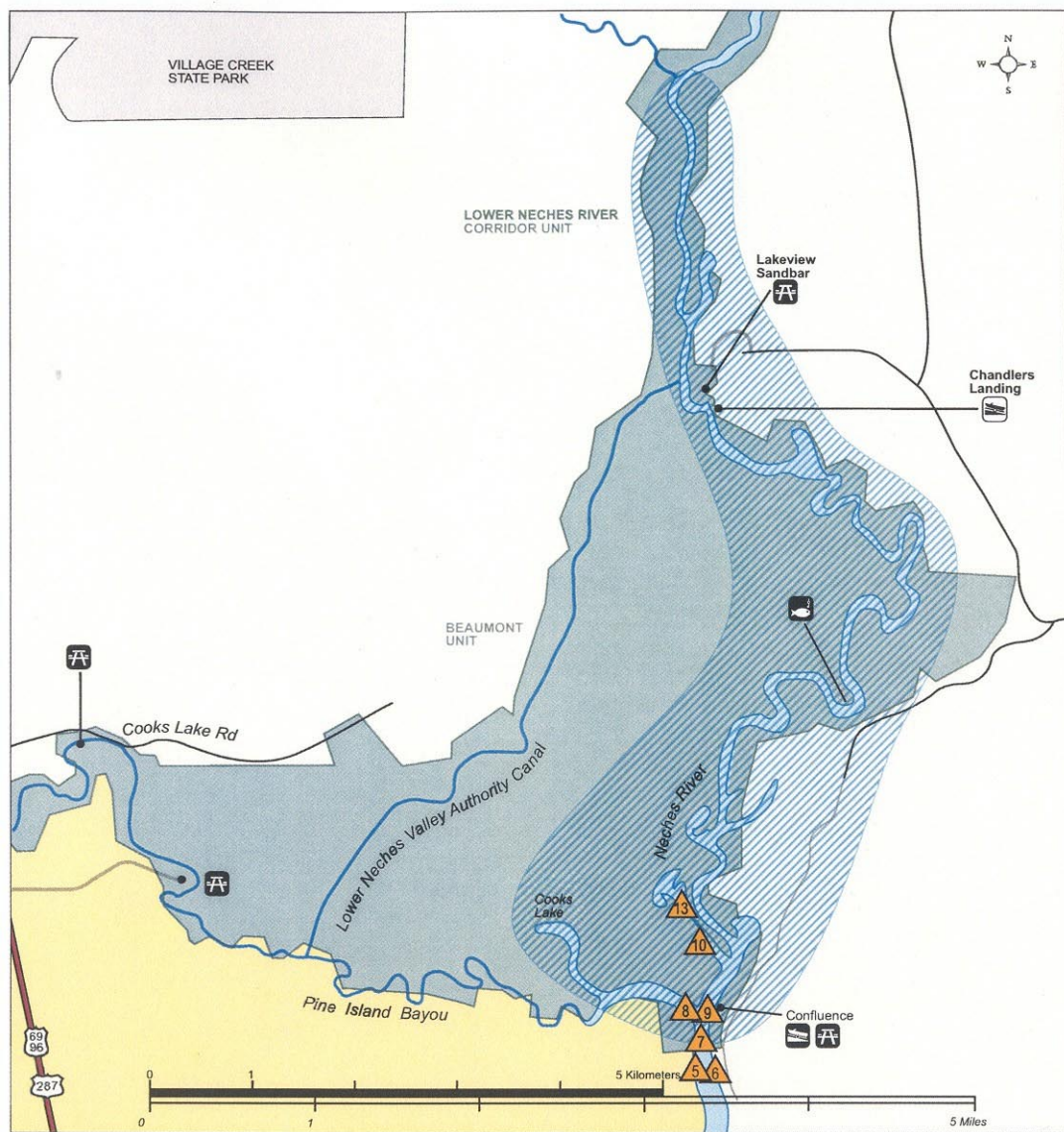
The 1995 summary includes data specifically from stations in the area where PWC use occurs (NPS 1995a). These are stations 5 through 10 and 13, shown on the Water Quality Monitoring Stations map. An examination of the EPA water quality criteria analysis for stations 5, 9, and 13 shows that the turbidity criterion was frequently exceeded (an average Secchi disc depth of about 0.4 meter, which indicates that the water is not very clear in this area). Water quality criteria for dissolved oxygen, zinc, chloride, sulfate, cadmium, copper, and lead were also exceeded at least once. Hydrocarbon samples were taken only at stations 8 and 9 in 1980. The older data show that all the hydrocarbons tested were below the detection limit used at that time.

The city of Beaumont withdraws water from the Neches River in the area of PWC use at its Bunn's Bluff intake. However, the city does not test its raw water, so no data are available from the city treatment plant. The city does test its treated water, and there have been no volatile or semi-volatile organics found above detection limits (Miller, pers. comm.).

The data available show that there are many possible sources of adverse impacts to the aquatic community of the Neches River, in addition to PWC-related pollutants. A number of adverse impacts to water quality in the Neches River are likely related to human activities such as residential development, industrial discharges, and oil and gas exploration. There have been exceedances of standards for fecal coliform, dissolved oxygen (DO), metals, salinity, and dioxin. In the early 1990s, concerns about dioxin levels resulted in the issuance of a fish consumption advisory for the lower Neches below Highway 96 at Evadale. This advisory was removed in 1995, after sampling results showed dioxin levels were below the acceptable level of risk (Harcombe and Calloway 1997). Several studies have indicated that the saltwater intrusion and industrial pollution carried into the Neches River decrease the habitat value of the lower reaches of the river for benthic communities (NPS 2001c).

PINE ISLAND BAYOU WATER QUALITY

The entire Pine Island Bayou watershed drains about 657 square miles before its confluence with the Neches River. The watershed is largely wooded but also contains substantial industrial and residential development. The watershed slopes in a southeasterly direction and varies in elevation from about 2 feet (above mean sea level) at the confluence to about 160 feet at the watershed divide (U.S. Army Corps of Engineers 1985). The only portion of Pine Island Bayou that is within the area of PWC use is the area from the mouth of Cook's Lake downstream to the confluence with the Neches River, a distance of less than 1 mile.



United States Department of the Interior / National Park Service WASO / April '02 / 175/20108

Big Thicket National Preserve Texas

Water Quality Monitoring Locations



Stream Segments, Uses, and Permits. The portion of Pine Island Bayou considered in this environmental assessment is part of stream segment 607, which extends upstream from the confluence with the Neches River. This segment is impaired in its upstream reaches due to depressed dissolved oxygen levels, but the portion within the park is not listed as impaired (TNRCC 2002). Designated uses for segment 607 are contact recreation, high quality aquatic habitat, and public water supply (TNRCC 2001a).

There are three discharges with National Pollutant Discharge Elimination System (NPDES) permits in the water corridor unit for sewage treatment plant effluent from Pinewood Estates, Bevil Oaks, and Lumberton. In 1992 eight NPDES municipal wastewater discharge permits were recorded for Pine Island Bayou for a total flow of 3.17 MGD. There are also 11 domestic outfalls into the bayou, for a total of 4.94 MGD (NPS 2001c).

Water Quality Data. Streams flowing through the Pine Island Bayou watershed are similar to other surface waters in southeastern Texas in that seasonal flows are variable and total dissolved solids (TDS) concentrations are relatively low. In addition to natural factors, land use practices in the watershed have influenced area water quality, generally contributing to its degradation. Water quality monitoring results have indicated that standards for chloride, dissolved oxygen, pH, and fecal coliform, all of which affect the health of the aquatic community, have been exceeded.

Most of these exceedances were found farther upstream from the area of PWC use. The 1995 NPS baseline water quality report (NPS 1995a) includes one station near the mouth of Pine Island Bayou, the primary area of PWC use (station 8). Data from this station (all from 1980) show no exceedances of water quality criteria or state standards for any of the organics or metals selected for sampling and analysis. No data are reported for standard parameters such as DO, turbidity, pH, or for pollutants that would come from personal watercraft, and no recent data are available for this site.

SENSITIVE AQUATIC SYSTEMS

The entire Neches River watershed and Pine Island Bayou confluence area can be considered sensitive, since they support a wide variety of fish and wildlife that help support Big Thicket's designation as a biosphere reserve. The entire riparian fringe is a wetland (primarily bottomland hardwood, with occasional littoral marsh), and its importance in the support of the structure and function of the national preserve's ecosystem is recognized.

Perhaps the aquatic areas most sensitive to disturbance and decline in water quality are the backwaters and oxbow lakes that fringe the main channel of the Neches (Photo 2). These areas do not receive the amount of flushing and dilution as the main channel and contain lush, dense habitat that support fish, invertebrates, and wildlife. Because they are also more removed from most of the noise and physical disturbance associated with large boats, skiers, and other recreationists who use the open water channel areas, they provide a quieter area for wildlife nesting, foraging, and breeding.

PHOTO 2: BACKWATER OXBOW LAKE

AIR QUALITY

The national preserve is north of the Beaumont / Port Arthur / Orange airshed and northeast of the Houston/Galveston airshed. Because of the large amount of industry (especially petrochemical industry) and urbanization in the area, these are two of the most polluted airsheds in Texas and represent two of five non-attainment areas in Texas that exceed national ambient air quality standards (NAAQS) established by the Environmental Protection Agency for ozone. Ozone can be both phytotoxic (having damaging effects on some vegetation) and injurious to humans and wildlife. Existing ozone levels may be increased by additional emissions of nitrogen oxides (NO_x) and volatile organic compounds (VOCs), the primary precursors to ozone formation.

The national preserve may also be influenced by air pollutants transported from the Lake Charles, Louisiana, petrochemical complex. The primary pollutants transported by airsheds affecting the national preserve are VOCs and NO_x . Other air pollutants that could affect the national preserve and public health and welfare include carbon monoxide, sulfur dioxide, and particulate matter (including heavy metals and lead).

During most of the year, prevailing air flow is from the southeast and the Gulf of Mexico, shifting to flow from the northwest during passages of major continental air masses (cold fronts) that generally occur in late fall, winter, and early spring. The airshed of the southern portions of the national preserve is also affected by air currents (inshore/offshore flows) from the Gulf of Mexico, with daily heating and cooling. These flow patterns are considered important because they transport various air pollutants from the nearby industrial and urban areas into the preserve.

Big Thicket National Preserve lies within the Beaumont / Port Arthur ozone non-attainment area, which includes Hardin, Orange, and Jefferson Counties. The area is in attainment with all other

national ambient air quality standards. The Beaumont / Port Arthur area did not meet an EPA 1999 deadline for attaining the 1-hour ozone standard. The Texas Natural Resource Conservation Commission subsequently submitted an attainment demonstration for the Beaumont / Port Arthur area that shows that the area is affected by ozone precursor pollutants transported southwest from the Houston / Galveston ozone non-attainment area. EPA approved the Beaumont / Port Arthur area's attainment demonstration on April, 19, 2000, based on an extensive transport and photochemical modeling analysis and associated control strategies. Under this plan, the 1-hour ozone standard must be met by November 15, 2007, or be classified as "serious."

The closest air monitoring stations to the national preserve are in Beaumont. The northernmost, station C54, does not report NO_x, NO₂, or ozone levels. The second station (CO2) is in south Beaumont and does regularly monitor SO₂, NO_x, NO₂, and ozone, plus wind and temperature parameters. The EPA AIRS database shows that air quality at this station has been in attainment with all national ambient air quality standards except ozone. Monitoring data for this site show that ozone levels exceeded the one-hour standard once in the year 2000, no times in 1999, and three times in 1998 (TNRCC ozone exceedance data, 2001). The one-hour ozone standard is violated when there are more than three exceedances over a three-year period.

In the fall of 1996 particulate matter (PM) was monitored in the national preserve as part of a special study by the Texas Natural Resource Conservation Committee, the National Park Service, and Mexico to increase understanding of the transport of pollution to the Big Bend area of Texas. The fine fraction of PM (i.e., particles less than 2.5 microns, or PM_{2.5}) was measured due to the interest in the dramatic effect this particle size has on visibility. Of the 18 sites monitored on both sides of the U. S. – Mexico border, the national preserve measured the highest levels of PM_{2.5} during a two-month period. Preliminary study findings indicate that fine sulfate particles comprised a significant portion of the PM_{2.5} measured at the national preserve, and that air masses arriving at Big Bend National Park from the Big Thicket area contained some of the highest levels of PM_{2.5} and sulfur compounds (NPS 2001c).

Use of personal watercraft could contribute to PM_{2.5} formation through emissions of SO₂, NO_x, and VOCs that are transformed in the atmosphere to fine particulate matter. Mean 24-hour average levels for PM_{2.5} (16.5 micrograms [µg] per cubic meter) measured in the national preserve during 1996 indicate ambient concentrations that exceed the newly promulgated annual average national ambient air quality standard (15 µg per cubic meter). However, implementation of this standard was blocked by a 1999 federal court ruling. If the levels measured are sustained and the new standard is ever reinstated, the national preserve would also be classified as a non-attainment area for fine particle national ambient air quality standards under the proposed EPA standard (NPS 2001c).

The national preserve's fire management program, nonfederal oil and gas operations, and motorized vehicle/watercraft use could locally affect air quality in the preserve and the surrounding area. However, industrialization (primarily petrochemical and public utility industries) and urbanization contribute more appreciably to air quality in the seven-county area of the national preserve and airsheds, as described earlier.

SOUNDSCAPES

One of the preserve's natural resources is the natural soundscape, also referred to as "natural ambient sounds" or "natural quiet." The natural soundscape includes all of the naturally occurring sounds of the preserve, such as wind in the trees, calling birds, insects, as well as the quiet associated with still

nights. As a “biological crossroads” with an unusual combination of plants and animals, Big Thicket has an uncommonly rich mix of natural sounds, which is an important part of the ecological functioning of the area (e.g., animal communication, predator/prey interaction) as well as the visitor experience (e.g., bird calls, solitude, tranquillity).

“Noise” is defined as unwanted sound. Sounds are described as noise if they interfere with an activity or disturb the person hearing them. When evaluated against the natural soundscape, which is all the sounds of nature in the absence of any human sound, all human sound is considered “noise.” This does not, however, imply that all human sounds are inappropriate or unacceptable; such evaluations must consider management guidance such as park purpose, management zoning, resource sensitivity, impacts from the activity, and similar factors.

Sound pressure levels are commonly measured in a logarithmic unit called a decibel (dB). The human ear is not equally sensitive to all sound frequencies, being generally less sensitive to very low and very high frequency sounds; therefore, the A-weighted decibel scale (dBA), which is calibrated to the human ear’s response, is often used in impact analysis. Table 1 illustrates common sounds and their associated sound levels using this scale.

TABLE 1: SOUND LEVEL COMPARISON CHART

Decibels	How it Feels	Equivalent Sounds
140-160	Near permanent damage level from short exposure	Large caliber rifles (e.g., .243, 30-06)
130-140	Pain to ears	.22 caliber weapon
100	Very loud	Air compressor at 20'; garbage trucks and city buses
	Conversation stops	Power lawnmower; diesel truck at 25'
90	Intolerable for phone use	Steady flow of freeway traffic; 10 HP outboard motor; garbage disposal
80		Muffled personal watercraft at 50'; automatic dishwasher; vacuum cleaner
70		Drilling rig at 200'; window air conditioner outside at 2'
60	Quiet	Window air conditioner in room; normal conversation
50	Sleep interference	Quiet home in evening; drilling at 800 feet
		Bird calls
40		Library
30		Soft whisper
20		In a quiet house at midnight; leaves rustling

Note: Modified from Final Environmental Impact Statement, Miccosukee 3-1 Exploratory Well, Broward County, Florida (U.S. Department of the Interior).

For the average human a 10 dB increase in the measured sound level is subjectively perceived as being twice as loud, and a 10 dB decrease is perceived as half as loud. The decibel change at which the average human would indicate that the sound is just perceptibly louder or perceptibly quieter is 3 dB. There is generally a 6 dB reduction in sound level for each doubling of distance from a noise source due to spherical spreading loss (e.g., if the sound level at 25 feet from a PWC was 86 dB, the sound level at 50 feet would be expected to be 80 dB, at 100 feet 74 dB, etc.).

NATURAL AND HUMAN SOUND LEVELS

A sound study was conducted at Big Thicket in 1998 to provide a rationale for protecting natural sounds at the preserve. As part of this evaluation, sound levels were recorded and monitored at various locations, including sounds from both natural and human sources. The study showed that the natural ambient sound level for most of the preserve is typically low and is primarily due to wind aloft in the trees (Foch 1999).

In the 1998 study natural ambient sound levels were recorded at two sites near the study area defined for this environmental assessment. One site is in the Beaumont Unit on the LNVA canal north of Cook's Lake, just outside the study area; this site is typical of backwater areas along the Neches River. The natural ambient sound level recorded in this area was 40.2 dBA. The other sound monitoring site was in the Lower Neches River Corridor Unit on the river near Evadale; this station is also outside the immediate project area, but has similar uses to that of the lower Neches River where motorized watercraft use occurs. The natural ambient sound level (i.e., L_{90}) recorded at this station was 43.4 dBA.*

Natural ambient sound levels varied considerably due to localized insects, wind in trees, vegetation differences, etc. It should also be noted that the measurements were taken from canoes floating on the river segments, and that the lower Neches River measurements included considerable conversation, as well as motorized recreational activities. Sources of noise that affect sound levels throughout the preserve include automobiles, boat motors, personal watercraft, motorcycles, all-terrain vehicles, various types of equipment (e.g., tractors, log skidders, chainsaws, and lawn mowers), air conditioners, power lines and transformers, and firearms. The majority of these noise sources are generally localized or seasonal in duration, thereby creating only temporary changes in background sound levels. The primary source of noise that affects sound levels along the lower Neches River is motorized watercraft, including powerboats and personal watercraft. Noise from residences and other human activities such as oil and gas development are also present in that area. Noise from personal watercraft and motorized boats varies considerably due to speed, behavior (e.g., jumping, maneuvering), engine size and type, and muffling. While decibel levels of personal watercraft and motorboats operated at a constant speed are roughly comparable to noise from automobiles being operated at a constant speed, their frequency spectra can be very different resulting in significantly different audibility, and therefore impacts. Also, when personal watercraft or boats change speeds, jump into the air or accelerate, their generated noise levels may increase dramatically and may reach maximums well over 80 dBA.

VISITOR RESPONSES TO PWC NOISE

As with all national preserve resources, the opportunity to experience the natural soundscape is part of the visitor experience. The natural soundscape of the preserve contributes to a positive visitor experience and is a direct or indirect component of why many people visit the national preserve. However, many visitors enjoy recreational activities using motorized watercraft, and noise is a component of that activity; such visitors do not necessarily visit the preserve for solitude or the soundscape. Visitor surveys regarding PWC noise in relation to visitor experience have not been conducted; therefore, it is difficult to quantify how many visitors enjoy the park for the natural soundscape compared to how many enjoy motorized recreational activities, or if some visitors enjoy both motorized activities and the natural soundscape. Information used in the analysis primarily comes from park staff observations and reports of complaints made formally and informally to park rangers.

* The values indicated are L_{90} values, representing the sound level exceeded 90% of the time. This is the level specified in NPS Director's Order #47 to use in estimating the natural ambient sound level when a single decibel descriptor is used.

Many factors affect how an individual responds to noise. Primary acoustical factors include the sound level, the distribution of sound levels across the frequency spectrum, and the duration (and other time-related factors such as how often it occurs, and timing sensitivity) of the sound. Secondary acoustical factors include the spectral complexity, sound level fluctuations, frequency fluctuation, rise-time of the noise, and localization of the noise source (Mestre Greve Associates 1992).

Non-acoustical factors also play a role in how an individual responds to sounds. Non-acoustical factors vary from the past experience and adaptability of an individual to the predictability of when a noise will occur. The listener's activity will also affect how he/she responds to noise.

Personal watercraft and outboard motors are similar in the actual noise level they generate (in terms of decibels), which is generally around 80 dB or less at 50 feet from a motorized boat or personal watercraft (PWIA n.d.) but can range from below 80 to as much as 102 dB (Sea-Doo 2000; Bluewater Network 2001). However, unlike motorboats, personal watercraft are highly maneuverable and are used for stunts and acrobatics, often resulting in quickly varying noise levels due to changes in acceleration and exposure of the jet exhaust when crossing waves. The frequent change in pitch and noise levels, especially if operated closer to land, make the noise from personal watercraft more noticeable to human ears (Asplund 2001).

WILDLIFE AND WILDLIFE HABITAT

The abundant and diverse vegetation of the national preserve supports aquatic and terrestrial habitats for a variety of fish and wildlife. Many studies of specific types of wildlife have been performed in the Big Thicket region over the past century. Some of the most thorough inventories were conducted shortly after the national preserve's establishment in 1974. The following section combines the results of these studies, literature reviews, and wildlife observations to describe fauna believed to inhabit the national preserve, with emphasis on those inhabiting the lower Neches River corridor. Rare, threatened, and endangered species of plants and animals are discussed beginning on page 49.

MAMMALS

Currently 60 species of mammals are either documented or believed to inhabit the national preserve. Several large species have been extirpated in Big Thicket due to factors such as habitat destruction and overhunting. These include the jaguar, ocelot, and red wolf (NPS 2001c). White-tailed deer and small mammals such as raccoons, opossums, bats, rabbits, squirrels, mice, voles, and rats are common along the riparian areas bordering the Neches River and Pine Island Bayou, where trees and other vegetation provide food and suitable habitat for denning, nesting, and cover (NPS 1974c).

BIRDS

Birds are the most visible and diverse group of vertebrate fauna in the national preserve, and 176 species have been documented to date. This figure is thought to be low because no comprehensive inventory of birds has even been performed (NPS 2001c). The national preserve lies on a major migratory flyway, and many species of birds are transient during spring and fall migrations. Birds found in Big Thicket predominantly consist of three categories: passerines (including many neotropical songbirds), raptors, and waterfowl. The abundance and variety of birds in Big Thicket contribute to one of the favorite visitor activities, bird watching. Birds that frequent the lower Neches

River corridor include a variety of ducks, gulls, herons, swallows, egrets, and sandpipers, plus osprey and wood stork. These birds use the open water and shoreline habitat, including the hardwood trees, for nesting and perch sites (NPS 2001c).

REPTILES AND AMPHIBIANS

Approximately 85 species of reptiles and amphibians are believed to inhabit the national preserve (Harcombe et al. 1996). This figure represents roughly 33% of the 235 species of reptiles and amphibians in Texas. The most diverse group of reptiles in Big Thicket is snakes. Texas has 68 species of snakes, and half of these inhabit Big Thicket. Other types of reptiles include skinks, lizards, turtles, and the American alligator. Three types of amphibians, including frogs, toads, and salamanders, inhabit Big Thicket. The Neches River and Pine Island Bayou riparian areas represent prime habitat for most of these species.

FISH

Of all faunal groups in the national preserve, fish are perhaps the most thoroughly inventoried: 92 species are believed to inhabit national preserve waters. In small tributaries, the most abundant species of fish include minnows, darters, bass, and bullhead catfish. This pattern shifts in larger tributaries, which are dominated by channel, blue, and flathead catfish; sunfish; largemouth and spotted bass; and crappie. Also considered very common in the Neches River drainage are threadfin shad, mosquito fish, and certain chubs, shiners, minnows, and darters (NPS 2001c). Snags in the river and its backwater areas provide habitat and cover for these fish and for invertebrates, a primary food item for many fish species.

INVERTEBRATES

A recent comprehensive inventory of invertebrates, which includes butterflies and moths, has documented over 1,800 species (Bordelon and Knudson 1999); this is believed to be the greatest species diversity in the contiguous United States. In aquatic environments, insects and mussels are the most thoroughly documented species. Comprehensive inventories in the Village Creek drainage have documented 249 species of common macroinvertebrates including dragonflies, caddisflies, mayflies, and stoneflies (NPS 2001c). It is expected that the Neches River and Pine Island Bayou would have similar species. Snags, in particular, are important habitat for these invertebrates.

Three species of aquatic insects are endemic to the Big Thicket region (Abbott et al. 1997), and two are candidates for federal listing. Thirty-four species of mussels, including the Texas heelsplitter, live in the Lower Neches River watershed (Howells 1996).

THREATENED, ENDANGERED, OR SPECIAL CONCERN SPECIES

The terms threatened and endangered describe the official federal status of certain species in Big Thicket National Preserve, as defined by the Endangered Species Act of 1973. The term candidate is used officially by the U.S. Fish and Wildlife Service (USFWS) when describing those species for which sufficient information is on file on the biological vulnerability and threats to support the issuance of a proposed rule to list, but rule issuance is precluded for some reason. No candidate species are currently believed to inhabit the national preserve. Species of concern are those species for

which listing may be warranted, but further biological research and field study are needed to clarify their conservation status. Texas has enacted regulations similar to the Endangered Species Act that confer threatened and endangered status to certain species inhabiting the state. NPS policies dictate that federal candidate species, species of concern, and state-listed threatened or endangered species are to be managed to the greatest extent possible as federally listed threatened or endangered species (NPS 1991). Therefore, these species are included in this discussion.

A consultation letter was sent to the U.S. Fish and Wildlife Service and a reply was sent on October 10, 2001 (see appendix B). The reply included county-based listings of species and suggested that attention be paid to potential disturbance of Texas trailing phlox and the paddlefish. Based on this information and preserve staff knowledge, a list of all federally listed and state listed species believed to occur permanently or transiently (such as migrating birds) in the national preserve (based on past inventories, existing and potential habitat, documented sightings, and professional judgement) was prepared and is presented in Table 2. Those that could be found or are likely to inhabit the area used by personal watercraft are discussed in more detail below. Much of the information presented is from

TABLE 2. STATE AND FEDERALLY LISTED CANDIDATE, THREATENED AND ENDANGERED SPECIES BELIEVED TO OCCUR IN BIG THICKET NATIONAL PRESERVE

Common Name	Latin Name	Potential for Occurrence	Federal Status	State Status
Birds:				
American Swallow-tailed Kite	<i>Elanoides forficatus</i>	*	N/L	T
Bachman's Sparrow	<i>Aimophila aestivalis</i>	0	N/L	T
Bald eagle	<i>Haliaeetus leucocephalus</i>	?	T	E
Peregrine Falcon	<i>Falco peregrinus anatum</i>	0	N/L	E
Peregrine Falcon	<i>Falco peregrinus tundrius</i>	*	N/L	T
Brown Pelican	<i>Pelicanus occidentalis</i>	?	E	E
Piping Plover	<i>Charadrius melodus</i>	?	T	E
Red-cockaded Woodpecker	<i>Picoides borealis</i>	0	E	E
White-faced Ibis	<i>Plegadis chihi</i>	?	N/L	T
Wood Stork	<i>Mycteria americana</i>	*	N/L	T
Fish:				
Blue Sucker	<i>Cycleptus elongatus</i>	0	N/L	T
Creek Chubsucker	<i>Erimyzon oblongus</i>	0	N/L	T
Paddlefish	<i>Polyodon spathula</i>	*	SOC	E
Insects:				
Caddisfly	<i>Phylocentropus harrisi</i>	?	SOC	N/L
Dragonfly	<i>Somatochlora margarita</i>	?	SOC	N/L
Mussel:				
Texas Heelsplitter	<i>Potamilus amphichaenus</i>	?	SOC	N/L
Mammals:				
Louisiana Black Bear	<i>Ursus americanus luteolus</i>	?	T	E
Rafinesque's Big-eared Bat	<i>Corynorhinus rafinesquii</i>	?	SOC	T
Southeastern Myotis Bat	<i>Myotis austroriparius</i>	?	SOC	N/L
Navasota Ladies'-Tresses	<i>Spiranthes parksii</i>	0	E	E
Slender Gay Feather	<i>Liatrus tenuis</i>	0	SOC	N/L
Texas Trailing Phlox	<i>Phlox nivalis</i> var. <i>texensis</i>	0	E	E
White Firewheel	<i>Gaillardia aestivalis</i> var. <i>winkleri</i>	0	SOC	N/L
Reptiles:				
Alligator Snapping Turtle	<i>Macrochelys temminckii</i>	*	N/L	T
Louisiana Pine Snake	<i>Pituophis melanoleucus ruthveni</i>	0	SOC	E
Northern Scarlet Snake	<i>Cemophora coccinea copei</i>	0	N/L	T
Smooth Green Snake	<i>Liophorophis vernalis</i>	0	N/L	E
Texas Diamondback Terrapin	<i>Malaclemys terrapin littoralis</i>	?	SOC	N/L
Timber Rattlesnake	<i>Crotalus horridus</i>	?	N/L	T

Note: Status: E = Endangered, T = Threatened, SOC = Species of Concern, N/L = Not Listed.

? = could possibly occur in PWC use area.

* = likely to occur in PWC use area.

0 = not expected in PWC use area.

personal observations and knowledge of the national preserve staff, because inventories of flora and fauna at Big Thicket are incomplete. The remainder of the species listed are not expected in the PWC use area because of lack of habitat, known ranges, or documented occurrences in the national preserve.

BIRDS

American Swallow-Tailed Kites (*Elanoides forficatus*). American swallow-tailed kites (state threatened) are migratory raptors that inhabit bottomland hardwood forests along major river bottoms in the southeastern United States and winter in South America. Kites historically bred throughout the southeastern United States; however, populations have declined in recent years. According to Rappole and Blacklock (1994), kite populations are now considered rare and local in Louisiana, South Carolina, and Georgia; good populations of kites are now only found in Florida. A recent survey of swallow-tailed kites in east Texas (Shackelford and Simmons 1999) documented 277 sightings and only one nest. Most sightings of kites in the national preserve have been reported in spring and summer months along the mid and upper portions of the Neches River. Although no kite nests have been found, the routine sightings of this species along the Neches strongly suggest that it may be nesting in mature bottomland forests in or near the national preserve.

Bald Eagle (*Haliaeetus leucocephalus*). Although formerly common, bald eagles (federal threatened and state endangered) are rare residents in east Texas. They prefer large lakes and rivers with tall trees along the shoreline. Bald eagles have been sighted most frequently near McQueen's landing in the Upper Neches River Corridor Unit and at the confluence of Menard Creek and the Trinity River in the Menard Creek Corridor Unit, but bald eagles have also been seen along the lower Neches River.

Peregrine Falcon (*Falco peregrinus*). Two subspecies of peregrine falcon are found in Texas: the American peregrine (*Falco peregrinus anatum*) and the Arctic peregrine (*Falco peregrinus tundrius*). Both species were delisted on August 25, 1999, but remain listed by the state as endangered and threatened, respectively. The American peregrine is a resident of the Trans-Pecos region, including Big Bend National Park and the Chisos, Davis, and Guadalupe Mountain Ranges. Arctic peregrines migrate through Texas twice a year to and from their wintering areas in South America. They stop on the Texas coast to feed before continuing their migration. In Big Thicket, peregrines (most likely the arctic subspecies) have been documented along the Neches River and in or near the Turkey Creek and Hickory Creek Units during spring and fall migrations.

Brown Pelican (*Pelicanus occidentalis*). The brown pelican (state and federally listed as endangered) is an uncommon permanent resident of the Texas coast. National preserve staff have observed pelicans near the terminus of the Neches River at Sabine Lake and at High Island southeast of Port Arthur; however, no pelicans have been documented in the national preserve. Pelicans might venture up the Neches River into the Beaumont Unit of the national preserve, but this would be a rare occurrence.

Piping Plover (*Charadrius melodus*). Piping plovers (federally threatened and state endangered) are uncommon winter residents along the Texas coast and are considered rare to casual transients in winter in the eastern third of the state. Piping plover habitat includes sand and gravel shorelines, river sandbars, and islands. No piping plovers have been documented in the national preserve; however, the lower Neches River provides a corridor for plovers to move inland from their coastal habitat. In addition, the large sandbars along the Neches River could provide nesting habitat.

White-Faced Ibis (*Plegadis chihi*). The white-faced ibis (state threatened) is predominantly a coastal species that inhabits a wide variety of freshwater and estuarine environments. The south Texas coast

appears to be the northern limit of the ibis's breeding range. This species is considered a rare transient in the eastern third of Texas during spring and fall migration (Rappole and Blacklock 1994), and it could be found in the national preserve. To date, no sightings of white-faced ibis have been documented in the national preserve.

Wood Stork (*Mycteria americana*). Wood storks (state threatened) have been seen in a variety of wetland and riverine locations throughout the national preserve, including along the Little Pine Island Bayou in the Lance Rosier Unit, the Beaumont Unit, and the Lower Neches River Corridor Unit. Storks in the national preserve are believed to be post-breeding transients from populations in southern Mexico. While these populations are considered stable, storks from separate breeding populations in Florida are listed as federally endangered due to habitat loss and low numbers. Storks may have bred historically in Texas, but no breeding populations are currently believed to exist. Preferred inland habitat includes large lakes and forested wetlands (Rappole and Blacklock 1994).

FISH

Paddlefish (*Polyodon spathula*). Paddlefish (federal species of concern) generally inhabit large rivers in the Mississippi River drainage and adjacent Gulf coastal plain. Paddlefish have been documented in the lower Neches River and at the confluence of the Neches River and Little Pine Island Bayou (Seidensticker 1994). Unlike most large riverine fish, paddlefish eat plankton, as opposed to other smaller fish. Paddlefish require cool temperatures, large flows, and gravel bottoms for spawning (Rosen and Hales 1981). The lower Neches River does not typically have sufficient flows and gravel substrate is uncommon, so spawning habitat is considered marginal. Nonetheless, the backwaters of the Neches could provide important feeding areas for paddlefish during the summer months. The Texas Parks and Wildlife Department recently developed a recovery plan for paddlefish in the Neches River; that plan includes annual stocking of paddlefish below Dam B on the upper Neches River corridor. The effectiveness of paddlefish recovery has yet to be documented.

AQUATIC INVERTEBRATES

Three species of aquatic invertebrates (all listed as federal species of concern) inhabit the national preserve: a caddisfly (*Phylocentropus harrisi*), a dragonfly (*Somatochlora margarita*), and a freshwater mussel (Texas heelsplitter; *Potamilus amphichaenus*). The Big Thicket emerald dragonfly is endemic to the Pineywoods region of east Texas. The caddisfly is endemic to the Gulf Coastal plain, and the Big Thicket region is near its western distributional limit. Little is known about the habitat preferences and locations of these species within the national preserve (Abbott and Stewart 1997). The Texas heelsplitter is a very rare mussel that has been found in the Neches River basin and most recently in Steinhagen Lake (Howells 1996). This mussel has never been documented in the national preserve, but the hydrologic connectivity of the Neches River and Steinhagen Lake makes its occurrence likely in the upper Neches and possibly in the lower Neches River.

MAMMALS

Only three listed mammals are believed to occur in or near to the national preserve: two species of bats and the Louisiana black bear.

Black Bear (*Ursus americanus* ssp. *luteolus*). The closest known reproducing populations of the Louisiana black bear (federal threatened and state endangered) is in the Atchafalaya Basin in

Louisiana. Occasional sightings of bears have been reported in east Texas, so occurrences of bears in the national preserve (especially wandering males) are possible. Two separate studies aimed at identifying potential habitat for black bear reintroduction have identified suitable habitat in the Neches Bottom / Jack Gore Baygall Unit (NPS 2001c; Epps 1997). This area could serve as core habitat for bears in the future through reintroduction efforts or expansion of existing populations in Louisiana. However, any reintroduction effort would require the active participation and support of a number of public and private land management agencies and the public to ensure the provision of sufficient habitat and to prevent poaching and other bear/human conflicts. Continued fragmentation of habitat in the Big Thicket and surrounding region could preclude the possibility of black bear reintroduction.

Rafinesque's Big-eared Bat (*Corynorhinus rafinesquii*). Rafinesque's big-eared bat (federal species of concern and state threatened) is easily distinguished from other bats by its immense ears. East Texas is considered the western distributional limit of this species. Preferred habitat for this species includes hollow trees, crevices behind bark, and dry leaves, although it is most frequently found in occupied and abandoned buildings (Davis 1974). A temporary roost was documented in the Little Pine Island Unit in 1995 (Horner and Maxey 1998), and occurrences elsewhere in the national preserve are likely (Schmidly et al. 1979).

Southeastern Myotis (*Myotis austroriparius*). The southeastern myotis (federal species of concern) is a rather small bat with dense, dull, woolly fur. This rare species reaches its western distributional limit in east Texas. In the Big Thicket region it is typically found in crevices between bridge timbers, culverts and drain pipes, structures, and hollow trees (Davis 1974). The bat is usually closely associated with water and often feeds over ponds and streams. It has been documented in the Beech Creek Unit, Neches Bottom / Jack Gore Baygall Unit, Lance Rosier Unit, and Loblolly Unit.

REPTILES

Alligator Snapping Turtle (*Macrolemys temminckii*). The alligator snapping turtle (state threatened) is considered one of the largest freshwater turtles in the world. It lives in deep, fresh waters with muddy bottoms (such as rivers, lakes, oxbows, and sloughs) and occasionally enters brackish water. The species is rare mainly due to international and domestic demand for its meat, although it has also declined as a result of habitat loss from reservoir construction, channelization of streams and rivers, placement of dredge spoil on riverbanks, recreational use of riverbanks and sandbars, removal of snags and water pollution (USFWS 1994; Ernst and Barbour 1972). Almost all of the units of the national preserve provide habitat for alligator snapping turtles. Alligator snappers have been documented in Turkey Creek, the Neches River, and Menard Creek. The Menard Creek specimen weighed 116 pounds and had a 26-inch diameter shell.

Texas Diamondback Terrapin (*Malaclemys terrapin littoralis*). The Texas diamondback terrapin (federal species of concern) generally inhabits brackish coastal areas, including tidal marshes, estuaries, and lagoons, and favors reedy marshes (University of Delaware 2001; University of Michigan 2001). Although it is unlikely to occur in the area of PWC use, it could possibly be seen in the more brackish areas of the lower Neches River corridor.

Timber Rattlesnake (*Crotalus horridus*). In the past, two subspecies of timber rattlesnake (state threatened) were believed to be in east Texas: the canebrake rattlesnake and the timber rattlesnake (Conant 1975). However, recent research suggests that the canebrake rattlesnake is simply a color variant and not a separate subspecies. Timber rattlesnakes have been documented in the Lance Rosier Unit, Turkey Creek Unit, and Big Sandy Unit and could possibly occur in the bottomland forests along the Neches River.

PLANTS

All listed plant species are fire-dependent upland species and/or known only in the upper Neches River area.

SHORELINES AND SHORELINE VEGETATION

Shoreline vegetation is very limited along the area of the Neches River and Pine Island Bayou where personal watercraft are used, where vegetation consists mainly of the root system of the trees and shrubs in the floodplain forest. Most banks are very sharp and do not support a vegetative community, and frequent flooding also limits the establishment of vegetation.

Most of the shoreline vegetation along the rivers where PWC use occurs is classified as floodplain hardwood forest, often generally referred to as bottomland hardwood forest (Photo 3). Dominant tree species in this type include sweetgum and water oak. Swamp cypress / tupelo forest can be found in secondary river and creek channels and along the fringe of oxbow lakes and sloughs throughout the floodplain forests of the national preserve. As the name implies, the dominant tree species are bald cypress and tupelo (NPS 2001c).

PHOTO 3: FLOODPLAIN FOREST (PINE ISLAND BAYOU)



In addition to the floodplain forests bordering the rivers, there are spotty occurrences of emergent plants along the shoreline (Photo 4). These palustrine emergent wetlands contain nonwoody aquatic plants such as rushes, arrowheads, sedges, grasses, vines, and other plants (NPS 2001c). Finally, there are several sandbars along the shoreline where vegetation is lacking immediately along the water/land boundary.

PHOTO 4: EMERGENT SHORELINE MARSH AND FLOODPLAIN FOREST



Erosion of streambanks occurs due to the water flow conditions in the river, especially the changes in flow from flooding and releases from upstream dams. The Neches is a very dynamic system, with flows that erode some areas and cause accretion in others. This natural meander process produces the sandbars and banks noticeable along this stretch of the Neches River (Photo 5).

PHOTO 5: SANDBAR ALONG NECHES RIVER SHORELINE



VISITOR USE AND EXPERIENCE

GENERAL WATERCRAFT USE

Watercraft use has occurred in Big Thicket prior to the time the national preserve was established in 1974. Watercraft at Big Thicket are primarily used for fishing and recreational boating, but are also used to access areas such as swim beaches and hunting locations, which are inaccessible via roads. A study conducted in May 1999 assessed what activities visitors were aware of at the preserve (Gulley 1999). For water-related activities, approximately 43% of visitors surveyed were aware that canoeing takes place at Big Thicket, while 34% knew about fishing, 22% about swimming, and 18% about motorized boating. Of all the activities mentioned in this survey, motorized boating was the least commonly known by visitors.

Observations made by staff at Big Thicket indicate that motorized watercraft use is not changing, while nonmotorized watercraft use is steadily increasing. Big Thicket estimates that roughly 70% of the watercraft used at the national preserve is motorized. The types of motorized watercraft, listed in order of relative abundance, include “John boats” (flat-bottomed boats), pleasure craft, bass boats, pontoon boats, and jet boats. Types of nonmotorized watercraft include canoes, kayaks, and an occasional pirogue.

Most of the water recreation in the area of the lower Neches River and Pine Island Bayou up to Cook’s Lake is dominated by motorized watercraft used for pleasure and general recreation and fishing boats, with some PWC use. Motorized watercraft used for pleasure tend to travel along the Neches River corridor and use the river at all times during the day, while fishing boats tend to remain in one area and are present primarily during the morning hours when the other motorboats are not present. Other types of watercraft (including canoes) are rare in this area because there are designated canoe routes elsewhere in the preserve that are more conducive to nonmotorized watercraft. However, there is a backwater area off of Pine Island Bayou, not far from its confluence with the Neches River, where canoeing and bird watching occur.

Most water-dominated units at Big Thicket are not conducive to watercraft use due to inaccessibility or lack of established boat ramps. Seasonal waterflows, submerged obstructions, and temporary saltwater barriers occasionally restrict navigability of the Neches River. In addition, the characteristics of water within Big Thicket (alluvial river, bayous, sloughs, swamps, and small blackwater streams) dictate types of water activities and watercraft accessibility. Given this, watercraft use at Big Thicket most commonly occurs in the Pine Island Bayou, Village Creek, and along the Neches River in four units (Upper Neches River Corridor, Neches Bottom/Jack Gore Baygall, Lower Neches River Corridor, and Beaumont). A 1999 visitor-survey indicates that the Beaumont and Neches Bottom/Jack Gore Baygall Units are the preferred locations for watercraft users (Gulley 1999).

In addition, other areas close to Big Thicket facilitate watercraft access and use. To the north of the Upper Neches River Corridor Unit is Steinhagen Lake, a publicly used recreational area. Steinhagen Lake flows into Big Thicket along the Neches River; however, access between these two areas via watercraft is not possible due to the dam. Watercraft users can, however, access Big Thicket from Village Creek State Park just west of the Lower Neches River Corridor Unit. Other waterbodies in the general vicinity of Big Thicket that allow watercraft use include Rayburn Reservoir, Sabine Reservoir, and the southern extent of the Neches River.

Most motorized watercraft use at Big Thicket occurs in the Beaumont Unit, while canoes and other nonmotorized equipment occur predominantly in the Village Creek Corridor (expansion area);

motorized watercraft tend not to travel here, and there are established paddle routes. Exact numbers of watercraft used are not available at this time, since no formal survey has been conducted and no permits are required for watercraft use. Geographic limitations, which were based on existing use patterns, were established for PWC use in the Superintendent's Compendium in 1999 (see appendix A).

Public boat launches at Big Thicket are maintained by the National Park Service and allow free access to the preserve. Private boat launches along the Neches River are maintained by individual owners, who sometimes charge fees to use them. Each of the four units that support watercraft use along the Neches River has at least one boat ramp (public or private). The most commonly used boat ramps in or near Big Thicket include Collier's Ferry (public), which is just south of the Beaumont Unit at the end of Pine Street; Confluence (public), inside the preserve at the south end of the Beaumont Unit; Evadale, at the north end of the Lower Neches River Corridor Unit; and Steinhagen Lake, to the north of preserve boundaries. Photo 6 depicts the Collier's Ferry access point.

PHOTO 6: COLLIER'S FERRY BOAT LAUNCH



PWC USE

Personal watercraft were first introduced at Big Thicket in the early 1980s. Since then, observations staff at Big Thicket made during scoping meetings in May 2001 indicate that PWC use has grown steadily until recently, when the numbers of PWC users seem to have leveled off. An exact number of PWC users at Big Thicket is not available at this time because PWC users have not been specifically counted; however, Big Thicket staff estimate that personal watercraft account for about 5%–10% of the total number of watercraft at the park on an annual basis. Big Thicket staff have indicated that during a typical high-use weekend day, about 12 personal watercraft can be observed along the lower Neches River, usually in smaller groups at sandbars along the river (e.g., at the Lakeview sandbar). Recently 24 personal watercraft were counted at the Confluence launch site on one weekend day (Big Thicket staff, pers. comm. 2001), but it is unclear if this included multiple counts of the same craft.

PHOTO 7: PWC USER ON RIVER

Table 3 summarizes the typical average use estimated for various use days over the year.

TABLE 3: ESTIMATED WATERCRAFT USE, BIG THICKET NATIONAL PRESERVE

	Days per Year	Larger "Sport" Boats and Pontoon Boats		Fishing Boats*		Personal Watercraft	
		Avg. No.	Hrs. Used	Avg. No.	Hrs. Used	Avg. No.	Hrs. Used
High Use Days — all summer weekends except holidays	26	46	6	15	4	12	4
Medium Use Days — remainder of summer days May through August	89	5	6	15	3	3	2
Low Use Days — all days in March, April, Sept., Oct., Nov.	150	3	3	10	3	.25	2
Very Low Use Days — all days in Dec., Jan., Feb.	90	0	0	5	2	0	0
No Use Days	10	0	0	0	0	0	0

Source: Big Thicket National Preserve staff (McHugh, pers. comm. 2001).

* About half larger than 50 hp, half smaller.

PWC use at Big Thicket most frequently occurs in the Neches River corridor near established campsites, launch areas, picnic grounds, docks/houses, or exposed sandbars (particularly Lakeview sandbar; see photo 8); PWC users often come in groups with only a limited number of personal watercraft and prefer to stay near the rest of the group located on the shore. This allows all the members of the group the opportunity to ride personal watercraft as well as recreate with their friends. Observations made by Big Thicket staff during May 2001 indicate that younger people predominantly use personal watercraft; however, there is also some PWC use by families and shoreline residents.

PHOTO 8: LAKEVIEW SANDBAR AREA

PWC users at Big Thicket are primarily local residents coming from within a roughly 20-mile radius. PWC users most often own their personal watercraft rather than rent them in part due to the limited number of rental businesses near Big Thicket. Four PWC distributors were interviewed in September 2001 regarding PWC use in the area. Two of the dealers said that PWC use has generally remained the same over the past five years, while the other two said that PWC use had decreased (Golden Triangle Cycle Center, Donalson Kawasaki, T&S Cycle, Kawasaki Country, pers. comm. 2001). Locals are the most common PWC consumer, and the majority of dealers stated that purchasing is more frequent than renting personal watercraft. In terms of locational trends, the dealers stated that PWC use most commonly occurs at local lakes, reservoirs, rivers, and the Gulf of Mexico. The majority of dealers also stated that two-stroke engines are the most common in the area, but that four-stroke engines are likely to be more prevalent in the future.

Staff at Big Thicket have received some complaints about PWC users, which include general rowdiness, noise, lack of consideration for fishermen and their lines, and choppy water (especially near the Collier's Ferry boat ramp) that makes it difficult for other watercraft to launch or dock.

NATIONAL PRESERVE VISITATION

Yearly visitation to the national preserve from 1978 to 2000 averaged approximately 65,000, but visitation generally increased during the period from 1987 to 1996 (NPS 2001c), and the average yearly visitation from 1990 to 2000 was 82,860 (Table 4). Since 1996, visitation has gradually decreased and appears to have leveled off. Visitation counts for each unit in the national preserve are unavailable at this time, therefore visitation in specific areas is largely based on visitor information station counts.

The majority of visitor use is regional. Yet the visitor registration log at the information station records annual visitation from all 50 states and at least 20 countries. It is likely that Big Thicket's biosphere reserve designation creates an international use pattern.

TABLE 4. ANNUAL VISITATION AT BIG THICKET NATIONAL PRESERVE

Year	Annual Visitation
1990	77,930
1991	64,076
1992	72,269
1993	82,854
1994	127,313
1995	115,466
1996	111,626
1997	77,633
1998	60,087
1999	60,193
2000	62,009
Average	82,860

SEASONAL USE PATTERNS

Watercraft use at Big Thicket, including personal watercraft, occurs most frequently during the summer on weekends. Holiday weekends at Big Thicket are not particularly crowded, because many watercraft users prefer sites outside the national preserve, such as Steinhagen Lake to the north. Watercraft use during the fall and winter is less common, mostly involving hunters traveling to areas inaccessible by foot or automobile.

Spring is the busiest visitor use period. Early spring travelers, mostly bird-watchers from a majority of states and several countries, converge on the general area. For several weeks in late spring school groups of up to 100 arrive daily to participate in educational programs at the national preserve. Weekend use increases as visitors from the region use trails and go fishing and boating.

Summer use is light because of high temperatures and humidity. Users are families from outside the region on traditional summer family vacations and visiting several attractions in a two- or three-week period. Local light visitation continues with fishing and boating activities.

Fall visitor use is moderate to high and consists of late seasonal travelers and school groups. Depending on weather conditions, regional visitor use can be high as people are enjoying outdoor recreation during cooler temperatures and humidities. Boating and fishing also occur during the fall months.

Winter use is light, with seasonal travelers consisting of retirees and some regional visitor use. During hunting season, from October through early January, up to 2,300 permits are issued for hunting in select units. Hunting limits other visitor uses, such as hiking, horseback riding, and off-road bicycling, due to safety issues and concerns. Boating and fishing are rare during the winter months.

VISITOR SAFETY

The 1980 *General Management Plan* for Big Thicket does not specify regulations or restrictions to watercraft use in the park; however, the National Park Service does enforce Texas regulations

pertaining to watercraft use (Texas water safety regulations can be found in title 4, chapter 31, subchapter A of the *Texas State Code*; Texas n.d.). Key regulations include the following:

- All personal watercraft must be registered.
- People born after 1984 must carry photo identification and a boater education certificate.
- People between the ages of 13 and 16 may operate a personal watercraft if they pass a boater education course.
- People younger than 16 cannot operate a PWC machine unless accompanied by an adult.
- A personal flotation device is mandatory.
- An automatic cutoff on the personal watercraft is required.
- No PWC operation is allowed from sunset to sunrise.
- No operation is allowed within 50 feet of another vessel, person, platform, object or shore unless at no-wake speed.
- The user must not operate the craft negligently, meaning awareness of other vessels, awareness of environmental concerns, and respecting the rights of shoreline property owners.
- No wake jumping is allowed.
- Users may not operate recklessly, meaning no excessive speed in regulated or congested areas, no operating in a manner that may cause an accident, no operating in a swimming area with bathers present, no operating in a manner that endangers life or property.
- Users may not operate under the influence of alcohol or drugs.
- All owners or operators must carry evidence of PWC insurance with them at all times.

An internal study by Big Thicket reports that from 1995 to 2000 there were 186 law enforcement actions involving watercraft in the preserve (NPS 2001c). Of these reported actions, a total of 52 involved personal watercraft and the remaining 134 were boat-related. Of the 52 PWC-related actions, 46 PWC users were issued citations and 6 were given warnings. The subject of these enforcement actions include creating a wake in a no-wake zone (28), not wearing a personal flotation device (8), not carrying a fire extinguisher (6), reckless driving (3), towing without lookout or mirror (2), driving under the influence of alcohol (1), being underage (1), having no registration (1), and operating within 50 feet of another watercraft (1).

There have been no reported fatalities or accidents involving personal watercraft, in part because personal watercraft are generally able to avoid collisions with unexpected obstacles if the driver is experienced and does not let up on the accelerator to the point at which steering is compromised. Also, personal watercraft can slow down relatively quickly in comparison to larger boats, which can continue forward for some distance even after the engine is shut down. Personal watercraft can also avoid submerged objects because they float higher than other watercraft.

CULTURAL RESOURCES

Cultural resources, including archeological sites, traditional Native American cultural properties, and historic sites, districts, buildings, and objects, are protected under section 106 of the National Historic Preservation Act of 1966, as amended.

No known cultural resources including any traditional cultural properties or sites listed on the National Register of Historic Places are known to occur along the lower Neches River corridor. A complete cultural resources inventory of this area has not been conducted. Cultural resources, including archeological and historic sites, are unlikely to occur along the lower Neches River corridor because floodplains are typically low probability areas for cultural resources due to the dynamics of the river exposing and washing away cultural remains. Isolated artifacts have been infrequently discovered in the cut-banks or along the shorelines of the lower Neches River, but these discoveries have rarely indicated the presence of additional buried, intact sites. Because a complete cultural resources inventory of the area has not been conducted, it is still possible that cultural resources may exist along the lower Neches River.

SOCIOECONOMIC ENVIRONMENT

A detailed description of the socioeconomic environment affected by PWC use at Big Thicket is provided in the report “Economic Analysis of Personal Watercraft Regulations in Big Thicket National Preserve” (Law Engineering and Environmental Sciences, Inc., et al. 2002).

Cities and towns in the vicinity of Big Thicket include Beaumont, Lufkin, Kountze, Silsbee, Woodville, Jasper, and Cleveland. These towns rely on tourism as an important part of their economies. However, PWC use in the preserve is not one of the primary forms of recreation in this area, especially for tourists. No PWC rental shops are located near Big Thicket. PWC use in the preserve is believed to be almost exclusively by PWC owners and dominated by local residents using their personal machines, although people from more distant areas who have a camp near Big Thicket may also use their machines in the preserve. In addition, alternative places for PWC recreation are nearby and are more popular destinations than Big Thicket because of their size and increased recreational opportunities. Also, many other leisure opportunities, such as boating, fishing, hiking, and bird watching, are available in the region.

While no PWC rental shops were identified in the immediate vicinity of the national preserve, three dealerships providing PWC sales and service were identified in the Beaumont area. In addition to personal watercraft, these establishments also rent and sell other equipment, such as all-terrain vehicles, motorcycles, and tractors. Even though year-to-year PWC sales appear to be quite variable, two of the three owners/operators indicated there has been a downward trend in PWC sales over the last few years. They attribute this trend to more vigorous enforcement of existing state and/or federal boating regulations. In other areas, PWC shop owners have indicated that they believe that the market for PWC sales is beginning to be saturated, and individuals tend to keep their watercraft for at least four or five years before upgrading to a new model.

Interviews with local PWC shops indicate that people who own camps along the Neches River frequently use their machines to recreate in the river as one of their daily activities while at their camp, although they may also trailer them to alternative areas for weekend trips. Other PWC users trailer their machines to the river and may spend some of their day on the river in Big Thicket and some of their day below the preserve boundary.

While PWC access between Steinhagen Lake and the national preserve is not possible because of a dam, watercraft users can access Big Thicket from Village Creek State Park just west of the Lower Neches River Corridor Unit. Other waterbodies in the general vicinity of Big Thicket that allow watercraft use include Rayburn Reservoir, Sabine Reservoir, Lake Livingston, Lake Houston, Toledo

Bend Reservoir, Keith Lake, Clam Lake, Gulf of Mexico, Galveston Bay, East Bay, and the southern extent of the Neches River.

In addition to businesses offering PWC sales and service, lodging establishments, restaurants, gas stations, and retail stores in the area could potentially be affected by changes in PWC use within the preserve. However, local businesses and park officials stated that almost all PWC users in this area are local. Thus, it is unlikely that businesses that focus on tourists from outside the region, such as lodging establishments or gift shops, would be affected by a change in park visitation by PWC users.

NATIONAL PRESERVE MANAGEMENT AND OPERATIONS

Currently 5.5 rangers are available at Big Thicket National Preserve for patrols and enforcement activities. Game wardens from the Texas Department of Parks and Wildlife enforce state regulations on boat activities and fishing. With regard to PWC use, only the launch site within the preserve at Beaumont is monitored. NPS staff have no control over the use of private launches along the lower Neches River. If state or NPS regulations are violated, warnings are given first, followed by citations (see page 61 for the types of citations issued over the last five years) at the discretion of the rangers based upon each case. Case incidents relating to PWC use violations are entered into a database.